(54) Title: SCRUBBING SPONGE AND METHOD FOR MAKING SAME

(57) Abstract

A scrubbing sponge (10) is disclosed which has a body and projections (14) extending from the body which are of greater density and preferably frusto-conical in shape. The mold (20, 30) for the sponge is preferably a two piece mold, one (20) of which contains vented cavities (24) which define the projections.

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I
TITLE

SCRUBBING SPONGE AND METHOD
FOR MAKING SAME

Field of Invention

This invention relates to artificial sponges for cleaning
purposes.

Background of the Invention

Sponges are used for a variety of cleaning purposes
including washing the human body and scrubbing floors. The
ordinary sponge is generally soft and pliable when wet.
Although various types of sculptured sponges have been used in
the past, for the most part all of them had a uniform surface
texture. Sponges have also been combined with plastic brushes
by clipping them or molding them to the plastic brush. These
products are typically more expensive than a sponge alone.
There is a need for a sponge which has a scrubbing surface as
well as a smooth surface that can be molded of a single
material. I provide a sponge which may be molded from
polyurethane using a two piece mold. My sponge preferably has
one flat face and an opposite face having frusto-conical
projections, the tips of which are significantly harder than
the surface of the sponge. These hard tips provided improved
scrubbing action. The tips are formed during the molding
process. The sponge is particularly useful for medical
applications.

Brief Description of the Drawings

Figure 1 is an perspective view of the sponge of the
present invention;
Figure 2 is a perspective view partially in section of the
mold used to make the sponge of Figure 1;
Figure 3 is a perspective view similar to Figure 2 after

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the mold has been filled with a foam material and the foaming reaction has been completed;

Figure 4 is a perspective view of the bottom half of a mold of Figure 2;

Figure 5 is a perspective view of the top half of the mold of Figure 2; and

Figure 6 is a graph of the data in Table I.

Description of the Preferred Embodiments

Referring to Figure 1, I provide a sponge which is preferably generally rectangular. Sponge 10 preferably has one flat underside surface which is not visible in the drawings and a top surface 12 having a plurality of frusto-conical projections 14. Each projection has a tip 16 which is substantially harder than the surface of sponge 10. These hard tips provide improved scrubbing action.

Sponge 10 is formed in a two piece mold shown in Figures 2 thru 5. The top 20 of the mold has a plurality of preferably frusto-conical cavities 24 each of which is connected to a vent tube 26 that extends through the top 20 of the mold. Cavities 24 could also be truncated pyramids or any similar shape in which diameters through the projection become progressively smaller as one moves toward the vent. The bottom half the mold 30 preferably has a generally rectangular cavity 32. This cavity 32 may have an insert or further cavity 34 to apply a brand name or other marking on the surface of the sponge. I prefer to provide for a depth of cavity 32 which will be equal to the height of the sponge and thereby form sides 18 of the sponge.

I prefer to make a sponge having a plurality of projections 14 which are approximately 0.25 inches in diameter at their base and have a height of 0.2 inches. Preferably, the height of sides 18 of the sponge is 0.375 inches. The base diameter of the projections 14 is preferably 0.35

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inches. I prefer to make the vent holes 26 approximately
0.07 inches in diameter. I have found that making a
frusto-conical cavity 24 having a sidewall which forms an
angle of 83 degrees from horizontal is most satisfactory. I
prefer to provide a 1/2 inch spacing between adjacent
frusto-conical projections 14. I further prefer to provide a
sponge which is two inches wide and three inches long.

In figure 3, I have shown the mold partially cut away
after it has been filled with the raw materials and allowed
to foam. When the raw materials are added to the mold they
are placed in the bottom half 30 of the mold. Sufficient raw
material is placed in mold cavity 32 so that during forming
the foam will pass through the vents 26. The amount of
material placed in the mold as well as the degree of venting
will affect the density of the foam. I prefer to make my
sponge of a density from 7 pounds per cubic inch to 18 pounds
per cubic inch. I have found that the HYPOL prepolymer of
W. R. Grace Company can be used to make a suitable foam
material.

During the foaming step the material which has been
placed in cavity 32 expands as carbon dioxide is generated.
Air in the mold escapes through vents 26. As the foam
expands, it fills cavities 24 and continues through vents 26
to form flashing 36 on top of the mold. After foaming has
completed that flashing 36 is removed and the top half 20 of
the mold is separated from the bottom half 30. During
foaming the material becomes much denser as it passes through
the frusto-conical section and vents 26. When the mold is
separated some flashing will remain attached to
frusto-conical portions 14. These rods of flashing 38 are
quite stiff and relatively dense. They can easily be broken
from the frusto-conical portion 14. When that is done a tip
16 of very dense material will remain. I have found that
dense hard tip provides an improved scrubbing feature to my
sponge. The density of the tip 16 and flashing 36 will be

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affected by the diameter and length of the vents 26. As the
foam passes through the frusto-conical section and vent 26
during the foaming cycle it will become dense because of the
progressively restrictive flow leading to the small opening of
the vent. Additionally, air escapes from the gas cells within
the foam as they break passing through vent 26.

The sizing of the vent holes will depend upon the nature of
the material used for the sponge and the length of the vents
26. The holes must be small enough to cause sufficient
densification, but not so small as to become clogged or to
prevent sufficient venting during molding. I have found that
fifteen vent holes approximately 0.07 inches in diameter work
well for a sponge 0.375 inches thick, three inches wide and four
inches long.

Although the sizing of the vent holes will determine the
difference in density of the projections and the density of the
sponge body, those skilled in the art will recognize other
factors which will determine the actual density of the body and
projections. Fillers could be added to increase density.
Density is also related to cell size and strength which can be
changed by many known techniques.

I have found that any projection which is harder or stiffer
than the sponge body provides improved scrubbing action.
However, it appears that the stiffest projections work best.
Since the stiffness of the projections is proportional to their
density in a homogenous formulation one can relate projection
density to density of the sponge body. Also since the density
of the scrubbing projections is apparently controlled by their
venting, a series of scrub sponges having different vent sizes
were used to determine the vent size at which the density of the
cones is maximized.

Sponges were made using a standard sponge mold having the
dimensions of 3" x 2" x .6". A series of different mold tops
having frusto-conical cavities with vent sizes ranging in

diameter from 19 mils to 133 mils with a vent length of 50 mils were used to make the sponges. The sponges were made from a 1:1 mixture of Hypol 2002 and water with 2% Brij 72. Enough material was poured into the mold so that approximately 50% would flow out of the vents. The sponges were demolded after approximately 8 minutes and allowed to cure several days wet. The sponges were frozen using liquid nitrogen and the cones were scythed from the body of the sponge. Both sponge bodies and cones were then dried for one half hour at 100% C followed by conditioning for three days at 50% relative humidity. The sponge bodies and cones were then weighed and measured. Densities for each were calculated and the density ratio was reported as the ratio of the density of the cone to that of the sponge body and the vent area is reported for a single vent. Table I reports the data shown are for single sponge body samples and an average of 5 cones scythed from that sponge.

Densities were calculated as follows:

Sponge body Density (lbs/ft^3) = w / ((l x w x h) - cf)) / .2625 where

   w = weight of sponge body in grams

   l = length of sponge body in inches

   w = width of sponge in inches

   h = height of sponge in inches

   cf = correction factor used to account for a lower volume for the sponge body due to corner round and logo

Scrub cone Density (lbs/ft^3) is

$$\frac{W}{\pi \times \frac{H}{3} \times \left(\left(\frac{D1}{2}\right)^2 + \frac{D1}{2} \times \frac{D2}{2} + \left(\frac{D2}{2}\right)^2\right)} \div .2625$$

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where w = weight of the cone in grams

H = the height of the cone in inches

D1 = the base diameter of the cone in inches

D2 = the tip diameter of the cone in inches

TABLE I

Vent Diameter (mils)	Vent Area (mils^2)	Density (lbs/ft^3) Body	Cone	Density Ratio
19	283.5	17.39	19.17	1.102
29	660.5	13.68	16.42	1.200
39	1194.6	13.16	15.88	1.207
50	1963.5	13.02	17.32	1.330
59	2734.0	12.68	19.16	1.511
70	3848.4	11.91	18.46	1.550
80	5026.5	13.44	21.34	1.588
94	6939.8	12.37	23.82	1.925
125	12271.8	10.76	20.23	1.880
133	13892.9	10.39	18.31	1.762

The date of Table I is plotted in Figure 6. Then, I fit a curve to the data point by regression analysis. The regression relation of density ratio to vent area using a 2nd degree polynomial is:

Density Ratio = $-8.572 \times 10^{-9} x^2 + 1.719 \times 10^{-4} x + 1.0478$

where X = area of vent in square mils. r^2 for the fit of the regression is .961775

Setting the first derivative equal to zero and solving for X determines the maximum density ratio. For the data of Table I, the curve shows maximum density ratio occurs at 10027

sq. mils or at 106 mils vent diameter. At that point there is
a maximum density ratio of 1.909. However, the density ratio
for the 94 mil vent indicate that slightly higher ratios or at
least 2 to 1 are possible. Moreover, one may be able to add
fillers or other additives to alter processing or achieve even
greater ratios.

During or after forming my sponge may be infused with
soap, fungicides, bacteriastats or other materials. The
choice of materials will depend upon the intended use of the
sponge.

While I have described and shown certain present
preferred embodiments by my sponge and mold for making same,
it should be understood that the invention is not limited
thereto, but may be variously embodied within the scope of the
following claims.

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I Claim:

1.   A sponge compromised of a foam body having a
density, and plurality of projections having a projection
density attached to the body wherein the projection density is
greater than the body density.

2.   The sponge of claim 1 wherein the projections are
frusto-conical.

3.   The sponge of claim 1 wherein the projections are
truncated pyramids or truncated polygons.

4.   The sponge of claim 1 wherein the projections have
a size and shape so that for any parallel, first and second
transverse cross-sections taken through the projections,
wherein the first transverse cross-section is closer to the
sponge body than the second transverse cross-section, the
first cross section will have greater area than the second
cross section.

5.   The sponge or claim 1 wherein a ratio of
projection density to body density is at least 1.5 to 1.

6.   The sponge of claim 1 wherein a ratio of
projection density to body density is greater than 2.0 to 1.

7.   The sponge of claim 1 also comprising at least one
filler in at least one of the body and the projections.

8.   A mold for forming a sponge having a body and a
plurality of projections extending therefrom compromising a
top portion and a bottom portion said portions having a size
and shape so that when fitted together they define a body

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cavity to form the body of the sponge, said top portion also having:

a) plurality of cavities each of which has a base and a tip said base being adjacent to the body cavity and having a diameter greater than a tip diameter through the tip; and

b) a plurality of vents each vent extending from the tip of the cavity through the top of the mold and having a diameter not greater than the tip diameter.

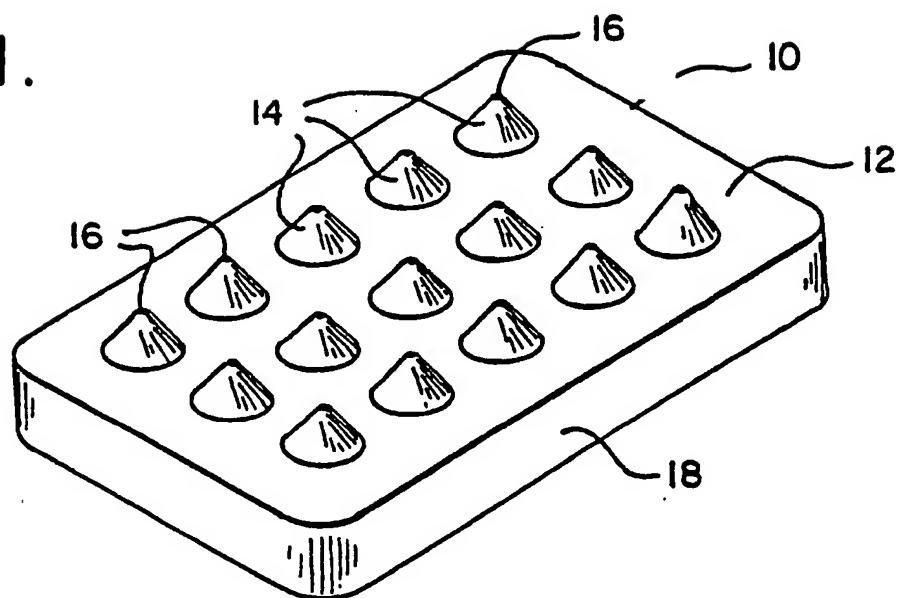9. The mold of claim 8 wherein the cavities are frusto-conical.

10. The mold of claim 8 wherein a body cavity is provided in the bottom portion of the mold.

11. The mold of claim 8 wherein each vent is at least 19 mils in diameter.

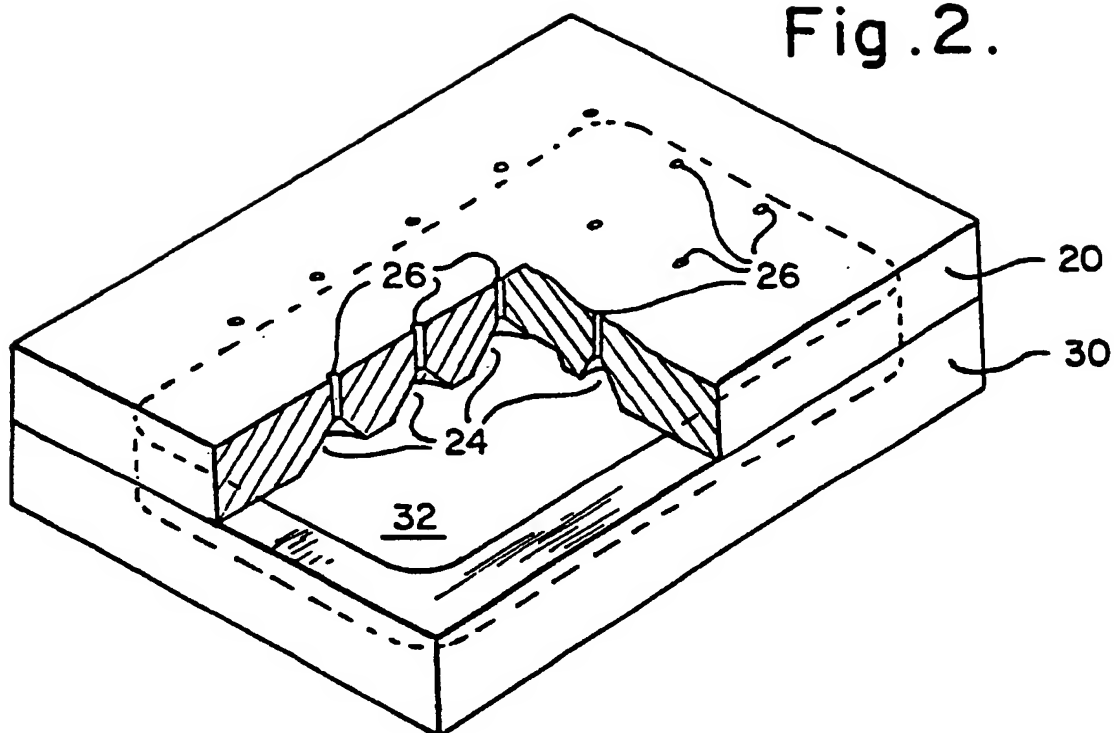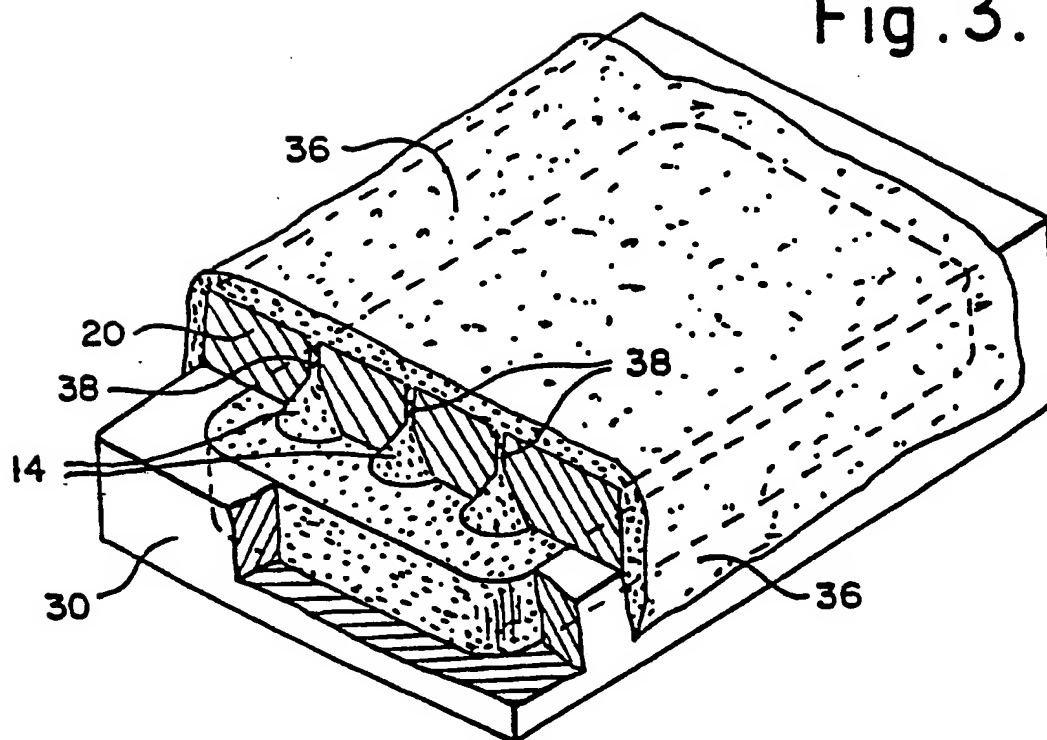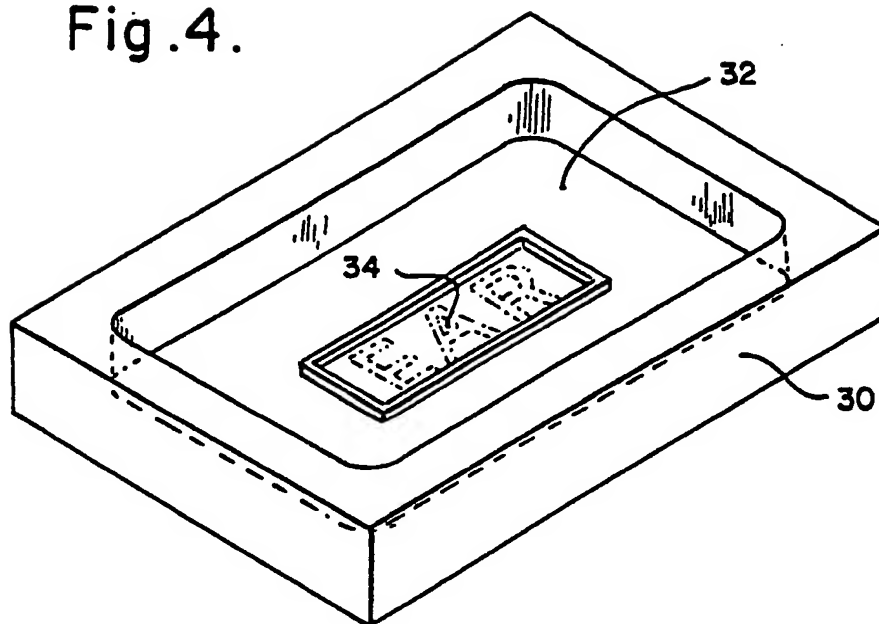12. The mold of claim 8 wherein each vent has a diameter not greater than 135 mils.
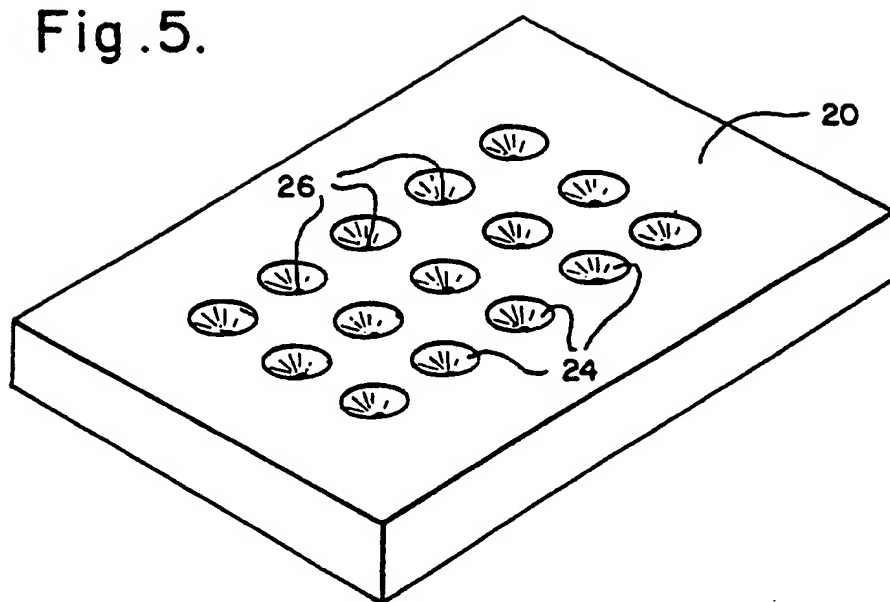
Fig.1.

Fig.2.

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Fig.3.

36

20

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14

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38

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Fig.4.

32

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Fig.5.

Fig.6.

INTERNATIONAL SEARCH REPORT

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4); A47L 13/17   B29C 1/00
U.S. Cl. 15/244.1

II FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	15/187,188,104.061,104.93,210.5,244.1,244.2,244.3, 244.4 249/83,141,160 425/812

Documentation Searched other than Minimum Documentation
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III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	U.S.,A, 1,987,390 DAVIS 08 January, 1935 (entire document)	1-6 7
X	U.S.,A, 1,877,527 MORAN 13 September, 1932 (entire document)	1-6
Y	U.S.,A, 4,613,446 MAGYAR 23 September, 1986	7
A	U.S.,A, 3,811,647 PINK 21 May, 1974	8-12
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21 November 1989	07 DEC 1989

International Searching Authority	Signature of Authorized Officer
ISA/US	Edward L. Roberts

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